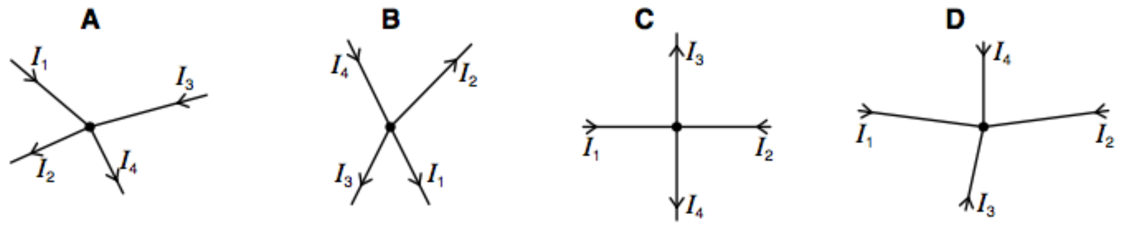
1)

The diagrams show connected wires which carry currents I_1, I_2, I_3 and I_4.

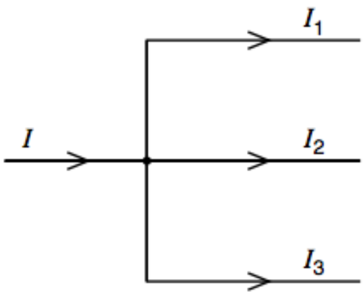
The currents are related by the equation $I_1 + I_2 = I_3 + I_4$.

To which diagram does this equation apply?



2)

At a circuit junction, a current I divides into currents I_1, I_2 and I_3.



These currents are related by the equation

$$I = I_1 + I_2 + I_3.$$

Which law does this statement illustrate and on what principle is the law based?

A Kirchhoff's first law based on conservation of charge

B Kirchhoff's first law based on conservation of energy

C Kirchhoff's second law based on conservation of charge

D Kirchhoff's second law based on conservation of energy

3)

The sum of the electrical currents into a point in a circuit is equal to the sum of the currents out of the point.

Which of the following is correct?

A This is Kirchhoff's first law, which results from the conservation of charge.

B This is Kirchhoff's first law, which results from the conservation of energy.

C This is Kirchhoff's second law, which results from the conservation of charge.

D This is Kirchhoff's second law, which results from the conservation of energy.

4)

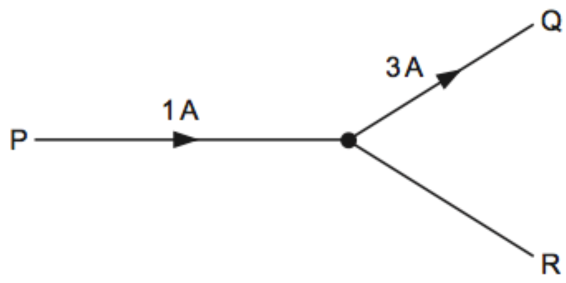
Kirchhoff's two laws for electric circuits can be derived by using conservation laws.

On which conservation laws do Kirchhoff's laws depend?

	Kirchhoff's first law	Kirchhoff's second law
A	charge	current
B	charge	energy
C	current	mass
D	energy	current

5)

The diagram shows a junction in a circuit where three wires P, Q and R meet. The currents in P and Q are 1 A and 3 A respectively, in the directions shown.



How many coulombs of charge pass a given point in wire R in 5 seconds?

A 0.4 **B** 0.8 **C** 2 **D** 10

6)

A student set up the circuit shown in Fig. 7.1.

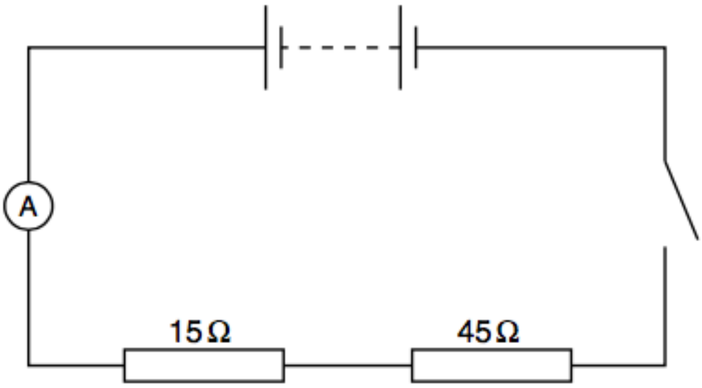


Fig. 7.1

The resistors are of resistance 15 Ω and 45 Ω. The battery is found to provide 1.6×10^5 J of electrical energy when a charge of 1.8×10^4 C passes through the ammeter in a time of 1.3×10^5 s.

(a) Determine

(i) the electromotive force (e.m.f.) of the battery,

e.m.f. = ... V

(ii) the average current in the circuit.

current = ... A
[4]

(b) During the time for which the charge is moving, 1.1×10^5 J of energy is dissipated in the 45 Ω resistor.

(i) Determine the energy dissipated in the 15 Ω resistor during the same time.

energy = ... J

(ii) Suggest why the total energy provided is greater than that dissipated in the two resistors.

....

....
[4]

7)

An electric heater is rated as 240 V, 1.2 kW and has constant resistance.

(a) For the heater operating at 240 V,

(i) show that the current in the heater is 5.0 A,

(ii) calculate its resistance.

resistance = ... Ω
[4]

(b) The heater in **(a)** is connected to a mains supply by means of two long cables, as illustrated in Fig. 7.1.

Fig. 7.1

The cables have a total resistance of 4.0 Ω. The voltage of the mains supply is adjusted so that the heater operates normally at 240 V. Using your answers in **(a)**, where appropriate, calculate

(i) the potential difference across the cables,

potential difference = ... V

(ii) the voltage of the mains supply,

voltage = ... V

(iii) the power dissipated in the cables.

power dissipated = ... W
[3]

(c) Using information from **(b)**, determine the efficiency ε at which power is transferred from the supply to the heater. That is, calculate

$$\varepsilon = \frac{\text{power dissipated in heater}}{\text{power input from supply}} .$$

efficiency = ...[2]

8)

Fig. 6.1 shows the variation with applied potential difference V of the current I in an electrical component C.

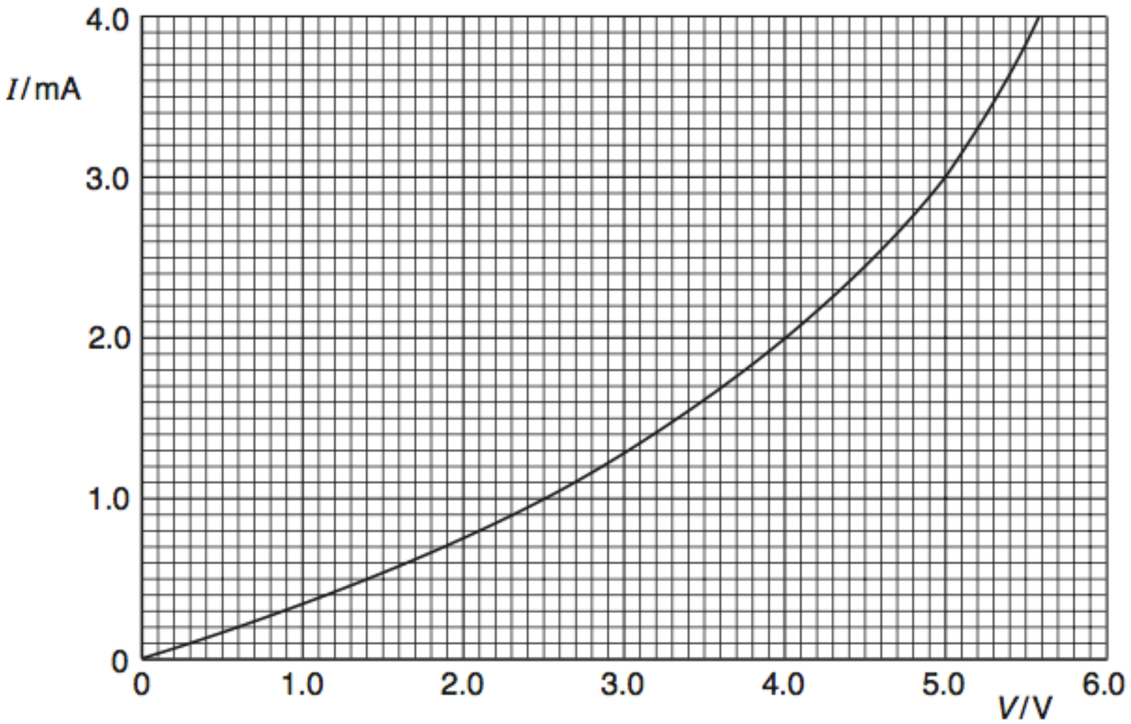


Fig. 6.1

(a) **(i)** State, with a reason, whether the resistance of component C increases or decreases with increasing potential difference.

....

.... [2]

(ii) Determine the resistance of component C at a potential difference of 4.0 V.

resistance = ... Ω [2]

(b) Component C is connected in parallel with a resistor R of resistance 1500 Ω and a battery of e.m.f. E and negligible internal resistance, as shown in Fig. 6.2.

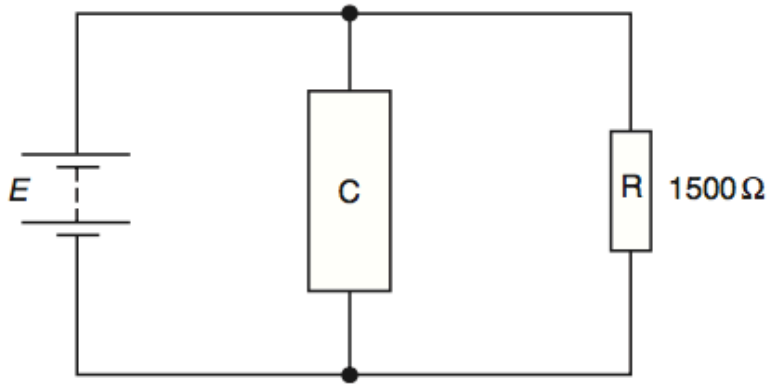


Fig. 6.2

(i) On Fig. 6.1, draw a line to show the variation with potential difference V of the current I in resistor R. [2]

(ii) Hence, or otherwise, use Fig. 6.1 to determine the current in the battery for an e.m.f. of 2.0 V.

current = ... A [2]

(c) The resistor R of resistance 1500 Ω and the component C are now connected in series across a supply of e.m.f. 7.0 V and negligible internal resistance.

Using information from Fig. 6.1, state and explain which component, R or C, will dissipate thermal energy at a greater rate.

....

....

....

.... [3]

9)

A circuit contains three similar lamps A, B and C. The circuit also contains three switches, S_1, S_2 and S_3, as shown in Fig. 7.1.

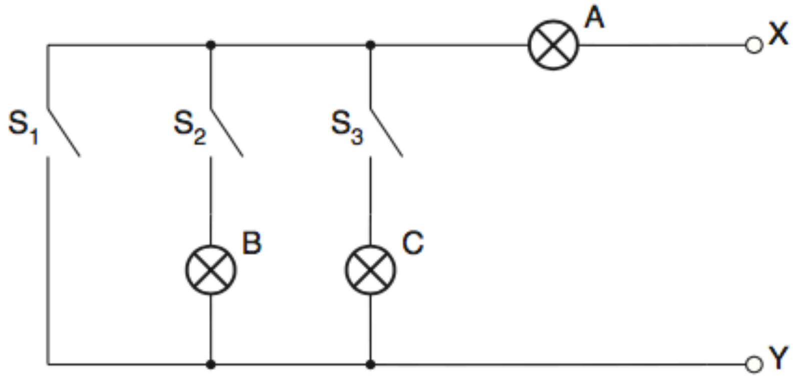


Fig. 7.1

One of the lamps is faulty. In order to detect the fault, an ohm-meter (a meter that measures resistance) is connected between terminals X and Y. When measuring resistance, the ohm-meter causes negligible current in the circuit.

Fig. 7.2 shows the readings of the ohm-meter for different switch positions.

switch S_1	S_2	S_3	meter reading / Ω
open	open	open	∞
closed	open	open	15 Ω
open	closed	open	30 Ω
open	closed	closed	15 Ω

Fig. 7.2

(a) Identify the faulty lamp, and the nature of the fault.

faulty lamp: ....

nature of fault: .... [2]

(b) Suggest why it is advisable to test the circuit using an ohm-meter that causes negligible current rather than with a power supply.

....

.... [1]

10)

A household electric lamp is rated as 240 V, 60 W. The filament of the lamp is made from tungsten and is a wire of constant radius 6.0×10^{-6} m. The resistivity of tungsten at the normal operating temperature of the lamp is 7.9×10^{-7} Ω m.

(a) For the lamp at its normal operating temperature,

(i) calculate the current in the lamp,

current = ... A

(ii) show that the resistance of the filament is 960 Ω.

[3]

11)

An electric heater consists of three similar heating elements A, B and C, connected as shown in Fig. 6.1.

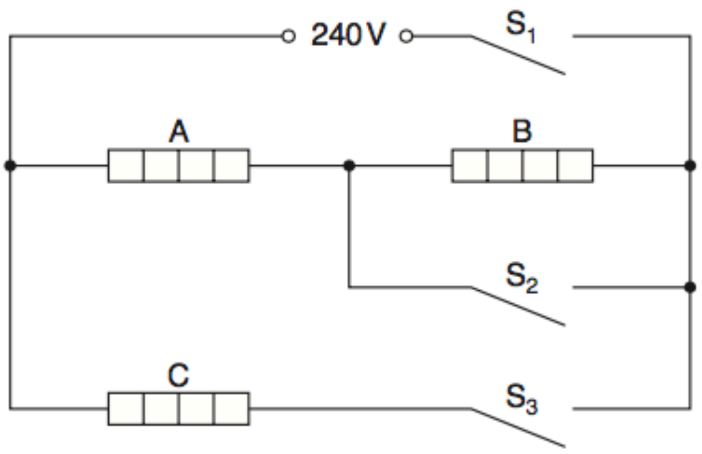


Fig. 6.1

Each heating element is rated as 1.5 kW, 240 V and may be assumed to have constant resistance.
The circuit is connected to a 240 V supply.

(a) Calculate the resistance of one heating element.

resistance = ... Ω [2]

(b) The switches S_1, S_2 and S_3 may be either open or closed.

Complete Fig. 6.2 to show the total power dissipation of the heater for the switches in the positions indicated.

S_1	S_2	S_3	total power / kW
open	closed	closed	....
closed	closed	open	....
closed	closed	closed	....
closed	open	open	....
closed	open	closed	....

[5]

Fig. 6.2

12) AQA and OCR B students can skip this question

(a) The current in a wire is I. Charge Q passes one point in the wire in time t. State

(i) the relation between I, Q and t,

.... [1]

(ii) which of the quantities I, Q and t are base quantities.

....

.... [2]

(b) The current in the wire is due to electrons, each with charge q, that move with speed v along the wire. There are n of these electrons per unit volume.
For a wire having a cross-sectional area S, the current I is given by the equation

$$I = nSqv^k,$$

where k is a constant.

(i) State the units of I, n, S, q and v in terms of the base units.

I ....

n ....

S ....

q ....

v ....
[3]

(ii) By considering the homogeneity of the equation, determine the value of k.

k = ... [2]